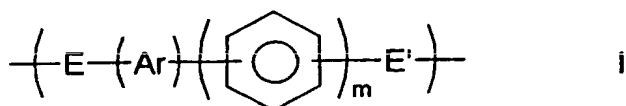
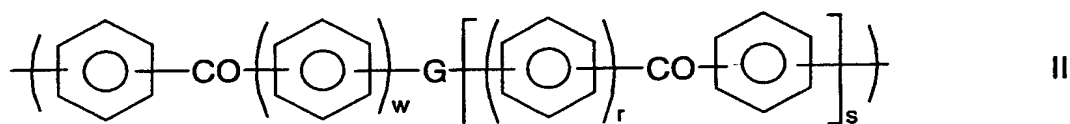


CLAIMS

1. A composite membrane which includes a conductive polymer and a support material for the polymer, said
 5 polymer having a moiety of formula

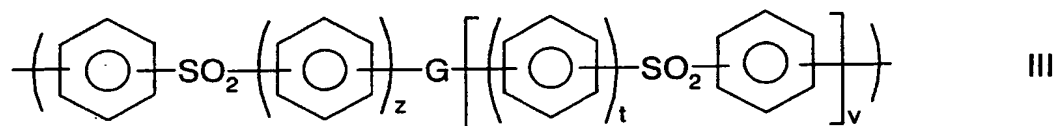


and/or a moiety of formula



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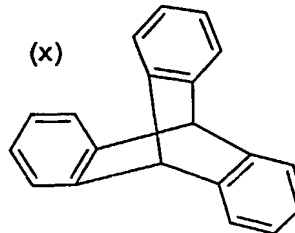
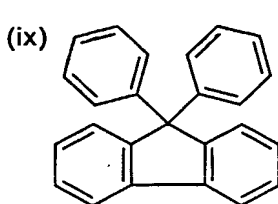
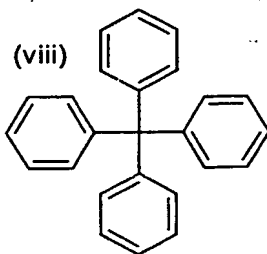
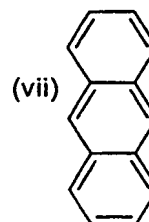
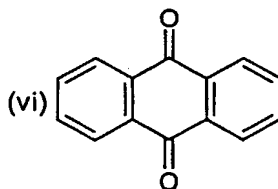
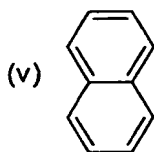
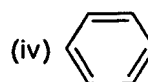
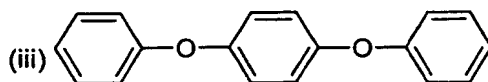
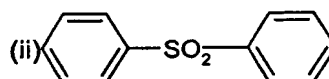
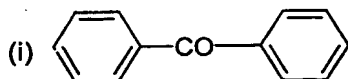
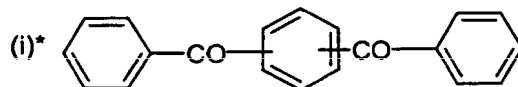
and/or a moiety of formula



- wherein at least some of the units I, II and/or III are
 15 functionalized to provide ion exchange sites; wherein the
 phenyl moieties in units I, II, and III are independently
 optionally substituted and optionally cross-linked; and
 wherein m, r, s, t, v, w and z independently represent zero or a
 positive integer, E and E' independently represent an
 20 oxygen or a sulphur atom or a direct link, G represents an
 oxygen or sulphur atom, a direct link or a -O-Ph-O- moiety

where Ph represents a phenyl group and Ar is selected from one of the following moieties (i)* and (i) to (x) which is bonded via one or more of its phenyl moieties to adjacent moieties

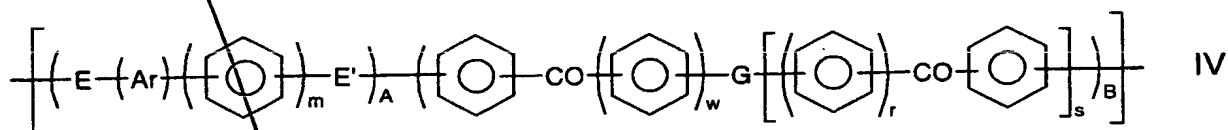
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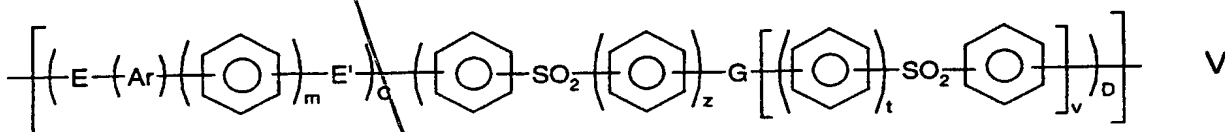
2. A membrane according to claim 1, where said first conductive polymer is sulphonated.

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3. A membrane according to claim 1 or claim 2, wherein said first conductive polymer is crystalline.

4. A membrane according to any preceding claim, wherein said polymer is a homopolymer having a repeat unit of general formula



or a homopolymer having a repeat unit of general formula



or a random or block copolymer of at least two different units of IV and/or V

wherein A, B, C and D independently represent 0 or 1.

5. A membrane according to any preceding claim, wherein said first conductive polymer includes at least some ketone moieties in the polymeric chain.

6. A membrane according to any preceding claim, wherein said first conductive polymer is a copolymer comprising a first repeat unit which is selected from the following:

(a) a unit of formula IV wherein E and E' represent oxygen atoms, G represents a direct link, Ar represents a

moiety of structure (iv), m and s represent zero, w represents 1 and A and B represent 1;

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(b) a unit of formula IV wherein E represents an oxygen atom, E' represents a direct link, Ar represents a moiety of structure (i), m represents zero, A represents 1, B represents zero;

10 (c) a unit of formula V wherein E and E' represent oxygen atoms, G represents a direct link, Ar represents a moiety of structure (iv), m and v represent zero, z represents 1 and C and D represent 1;

15 (d) a unit of formula V wherein E represents an oxygen atom, E' represents a direct link, Ar represents a moiety of structure (ii), m represents 0, C represents 1, D represents 0; or

20 (e) a unit of formula V wherein E and E' represents an oxygen atom, Ar represents a structure (i), m represents 0, C represents 1, Z represents 1, G represents a direct link, v represents 0 and D represents 1;

25 and a second repeat unit which is selected from the following:

(f) a unit of formula IV wherein E and E' represent oxygen atoms, G represents a direct link, Ar represents a moiety of structure (iv), m represents 1, w represents 1, s represents zero, A and B represent 1;

30

(g) a unit of formula IV wherein E represents an oxygen atom, E' is a direct link, G represents a direct link, Ar

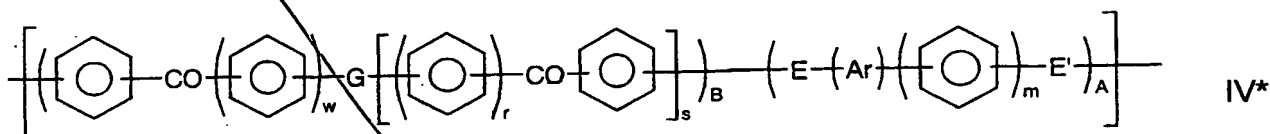
represents a moiety of structure (iv), m and s represent zero, w represent 1, A and B represent 1;

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cont
(h) a unit of formula V wherein E and E' represent oxygen atoms, G represents a direct link, Ar represents a moiety of structure (iv), m represents 1, z represents 1, v represents 0, C and D represent 1; and

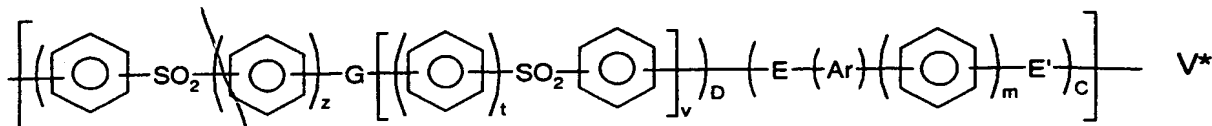
10 (i) a unit of formula V wherein E represents an oxygen atom, E' represents a direct link, G represents a direct link, Ar represents a moiety of structure (iv), m and v represent zero, z represents 1, C and D represent 1;

15 7. A membrane according to claim 6, wherein said first conductive polymer includes a first repeat unit selected from repeat units (b), (d) or (e) in combination with a second repeat unit selected from units (f) or (h).

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8. A membrane according to any preceding claim, wherein said first conductive polymer is a homopolymer having a repeat unit of general formula



or a homopolymer having a repeat unit of general formula



or a random or block copolymer of at least two different units of IV* and/or V* wherein A, B, C and D independently represent 0 or 1.

9. A membrane according to any preceding claim, wherein said first conductive polymer includes a biphenylene moiety.
10. A membrane according to any preceding claim, wherein said first conductive polymer includes a -O-biphenylene-O-moiety.
11. A membrane according to any preceding claim, wherein a film of said conductive polymer is laminated to the support material.
12. A membrane according to any of claims 1 to 10, wherein the support material is porous and said conductive polymer is impregnated in the support material.
13. A membrane according to any preceding claim, wherein said support material comprises a polymer having a moiety of formula I, II and/or III as described in any preceding claim except that the polymer of the support material is either not sulphonated (or otherwise functionalised to provide ion-exchange sites) or is only sulphonated (or otherwise functionalised to provide ion-exchange sites) at or in the region of the surface of the support material.

14. A membrane according to any preceding claim, wherein said support material is selected from the following homopolymers of formula IV as shown in claim 4:

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cont
- E and E' represent oxygen atoms, G represents a direct link, Ar represents a moiety of structure (iv), m and s represent zero, w represents 1 and A and B represent 1
 - 10 - E represents an oxygen atom, E' represents a direct link, Ar represents a moiety of structure (i), m represents zero, A represents 1, B represents zero
 - Ar represents a moiety (iv), E and E' represent oxygen
 - 15 atoms, G represents a direct link, m represents 0, w represents 0, s represents 1, r represents 1 and A and B represent 1.
 - Ar represents a structure (i)*, E represents an oxygen
 - 20 atom, E' represents a direct link, m represents 0, A represents 1, B represents 0.
 - Ar represents moiety (i), E and E' represent oxygen
 - atoms, G represents a direct link, m represents zero, w
 - 25 represents 1, r represents 0, s represents 1 and A and B represent 1
 - Ar represent moiety (iv), E represents a sulphur atom,
 - m represents 0, E' represents a direct link and B
 - 30 represents 0;

or is selected from:

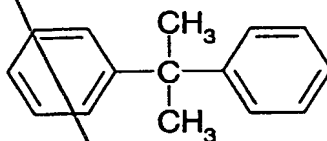
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cont
- a homopolymer of formula V wherein E represents an oxygen atom, E' represents a direct link, Ar represents a moiety of structure (ii), m represents 0, C represents 1, D represents 0; and is selected from:
 - polysulphone for example comprising a homopolymer of formula V wherein E and E' represent oxygen atoms, m represents zero, C and D represent 1, z represents 1, G represents a direct link, v represents zero and Ar represents a moiety of structure:

10



15. A membrane according to any preceding claim, wherein said first conductive polymer has an equivalent weight (EW) of less than 800g/mol, preferably less than 500 g/mol.

16. A conductive polymer and a support material for the polymer, wherein said polymer includes:
- 20 polyaryletherketone and/or polyarylethersulphone units; and units of formula -O-Ph_n-O- (XX) wherein Ph represents a phenyl group and n represents an integer of 2 or greater and wherein Ph groups of units (XX) are sulphonated.

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- 25 17. A fuel cell or electrolyser incorporating a composite membrane according to any preceding claim.

18. A method of making a composite membrane according to any of claims 1 to 16, the method comprising causing a
- 30 conductive polymer as described in any of claims 1 to 16

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cont to be associated with a support material as described in
any of claims 1 to 16.

19. A method according to claim 18, which includes
5 impregnating porous support material with conductive polymer.

Sub A4
10 20. A method according to claim 18 or claim 19, wherein a first solvent formulation comprises a polar aprotic solvent in which a conductive polymer is provided and said support material is a material (e.g. a polyetheretherketone fabric or a polyetherketone microporous membrane) which is not soluble in said polar aprotic solvent, wherein the method includes a step of
15 contacting said support material with said first solvent formulation.

21. A method according to claim 18 or claim 19, wherein said support material is a fabric and the method includes
20 a step of contacting the fabric with a first solvent formulation comprising a first solvent and said conductive polymer, wherein said first solvent and said support material are selected so that the first solvent solubilizes a surface of the support material.

25

22. A method according to claim 21, wherein said first solvent is capable of functionalising said support material to provide ion-exchange sites on the surface thereof.

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23. A method according to claim 22, wherein said first solvent includes less than 99% acid.

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24. A method according to claim 18 or claim 19, the method including:

- 5 contacting said support material with a solvent formulation comprising a first solvent which solubilizes the support material; and
 contacting the support material with a second solvent to cause phase inversion and render said support material porous.

- 10 25. A method according to claim 24, wherein said conductive polymer is provided in a third solvent and caused to penetrate pores in the support material.